BID SOLICITATION

STATE OF RHODE ISLAND AND PROVIDENCE PLANTATIONS
CAPITOL HILL
PROVIDENCE RI 02908

BID NUMBER: B03465

TITLE: SHEETING, REFLECTORIZED

BID OPENING DATE AND TIME:

03/19/2004 10:00 AM

BUYER: NANCY MCINTYRE
PHONE #: (401) 222 - 2142 ext. 126
BLANKET PERIOD: 4/1/04 - 3/31/07

BILL TO

TRANSPORTATION
DOT MAINTENANCE BUSINESS OFFICE
360 LINCOLN AVE
WARWICK RI 02888

SHIP TO

TRANSPORTATION
DOT MAINTENANCE DIVISION
MAIN OFFICE
360 LINCOLN AVE
WARWICK RI 02888

Requisition Number(s): R70B043586

Item	Class-Item	Quantity	Unit	Unit Price	Total
	BLANKET REQUIREMENTS: 4/1/04 - 3/31/07 REFLECTIVE MATERIALS AND ALLIED ITEMS USED FOR MANUFACTURING/RECONSTRUCTING SIGNS STATEWIDI				

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	BIDDING (a) A single price shall be quoted for each item against which a proposal is submitted. This price will be the maximum in effect during the agreement period. Any price decline at the manufacturer's level shall be reflected in a reduction of the agreement price to the State. (b) Quantities, if any, are estimated only. The agreement shall cover the actual quantities ordering during the period. Deliveries will be billed at the single, firm, awarded unit price quoted regardless of the quantities ordered. (c) Bid price is net F.O.B. destination and shall include inside delivery at no extra cost. (d) Bids for single items and/or a small percentage of total items listed, may, at the State's sole option, be rejected as being non-responsive to the intent of this request. ORDERING (a) The User Agency(s) will submit individual orders for the various items and various quantities as may be required during the agreement period. (b) Exception - Regardless of any agreement resulting from this bid, the State reserves the right to solicit prices separately for any extra large requirements for delivery to specific destinations.				

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Requisition Number(s): R70B043586

Item	Class-Item	Quantity	Unit	Unit Price	Total
	THIS IS A MULTI-YEAR BID/CONTRACT. PER RHODE ISLAND STATE LAW 37-2-33, CONTRACT OBLIGATIONS BEYOND THE CURRENT FISCAL YEAR ARE SUBJECT TO AVAILABILITY OF FUNDS. CONTINUATION OF THE CONTRACT BEYOND THE INITIAL FISCAL YEAR WILL BE AT THE DISCRETION OF THE STATE. TERMINATION MAY BE EFFECTED BY THE STATE BASED UPON DETERMINING FACTORS SUCH AS UNSATISFACTORY PERFORMANCE OR THE DETERMINATION BY THE STATE TO DISCONTINUE THE GOODS/SERVICES, OR TO REVISE THE SCOPE AND NEED FOR THE TYPE OF GOODS/SERVICES; ALSO MANAGEMENT OWNER DETERMINATIONS THAT MAY PRECLUDE THE NEED FOR GOODS/SERVICES. ALL VENDORS MUST INCLUDE SPECIFICATIONS WITH BID PROPOSAL (EVEN THOSE BIDDING BRAND SPECIFIED). FAILURE TO SUBMIT SPECIFICATIONS WITH BID PROPOSAL MAY RESULT IN DISQUALIFICATION OF BID. ITEMS IN CATALOGS MUST BE CLEARLY MARKED AND PAGES TABBED. IF SAMPLES ARE REQUESTED, THEY MUST BE PROVIDED WITHIN TEN (10) WORKING DAYS OF REQUEST DATE. FAILURE TO DO SO MAY RESULT IN DISQUALIFICATION OF BID.				

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Item	Class-Item	Quantity	Unit	Unit Price	Total
	ALL MATERIAL IS FOR MANUAL APPLICATION. SHEETING MATERIAL TYPE IS PER ATTACHED RIDOT SPECIFICATION. PAPER PRE-SPACING TAPE MUST BE SMOOTH AND UNDAMAGED DURING MANUFACTURING PROCESS - (NO END CUTS - CLAMPING DAMAGES THE ROLL)				
1.0	550-45 PAPER PRE-SPACING TRANSFER TAPE - 2" X 100 YDS (PRICE PER ROLL)	1.00	ROLL	_____	_____
2.0	550-45 PAPER PRE-SPACING TRANSFER TAPE - 4" X 100 YDS (PRICE PER ROLL)	1.00	ROLL	_____	_____
3.0	550-45 PAPER PRE-SPACING TRANSFER TAPE - 8" X 100 YDS (PRICE PER ROLL)	1.00	ROLL	_____	_____
4.0	550-45 PAPER PRE-SPACING TRANSFER TAPE - 12" X 100 YDS (PRICE PER ROLL)	1.00	ROLL	_____	_____
5.0	550-45 PAPER PRE-SPACING TRANSFER TAPE - 24" X 100 YDS (PRICE PER ROLL)	1.00	ROLL	_____	_____

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Item	Class-Item	Quantity	Unit	Unit Price	Total
6.0	550-45 E.C. OVERLAY FILM TRANSLUCENT VARIOUS COLORS - UN-PUNCHED	1.00	SQFT		
7.0	550-45 NON-REFLECTIVE FILM (BLACK-VINYL) - UN-PUNCHED (PER SQUARE FOOT)	1.00	SQFT		
8.0	550-45 REFLECTIVE SHEETING TYPE IIIA OR TYPE IIIB - UN-PUNCHED (PER SQUARE FOOT)	1.00	SQFT		
9.0	550-45 REFLECTIVE SHEETING TYPE IIIA OR TYPE IIIB - CUT-ABLE UN-PUNCHED (PET SQUARE FOOT)	1.00	SQFT		
	FOR ITEMS 10-13, BID A PRICE PER FIFTY (50) SIGN FACES				
10.0	550-45 30" R1-1 STOP SIGN FACES - (PER 50) - TYPE VI SHEETING	1.00	EA		
11.0	550-45 36" R1-1 STOP SIGN FACES - (PER 50) - TYPE VI SHEETING	1.00	EA		
12.0	550-45 36" R1-2 YIELD SIGN FACES - (PER 50) - TYPE VI SHEETING	1.00	EA		

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Item	Class-Item	Quantity	Unit	Unit Price	Total
13.0	550-45 30" R5-1 DO NOT ENTER SIGN FACES - (PER 50) - TYPE VI SHEETING	1.00	EA		
14.0	550-45 BLACK BORDER TAPE 3/4", 1", OR 1 1/4" X 50 YDS	1.00	ROLL		
15.0	550-45 TYPE IIIA OR TYPE IIIB WHITE BORDER TAPE 3/4", 1", 1 1/4", 1 1/2", 1 3/4", OR 2" X 50 YDS.	1.00	ROLL		
16.0	550-45 FLUORESCENT YELLOW GREEN TYPE VI SHEETING	1.00	SQFT		
17.0	550-45 HIGH PERFORMANCE RETRO-REFLECTIVE FILM (7 YEAR) UN-PUNCHED	1.00	SQFT		
18.0	550-45 HIGH PERFORMANCE CAST VINYL FILM (8 YEAR) PUNCHED - 15" X 50 YDS.	1.00	SQFT		
19.0	550-45 HIGH PERFORMANCE CAST VINYL FILM (8 YEAR) UN-PUNCHED	1.00	SQFT		
20.0	550-45 CONSPICUITY TAPE - 2" X 50 YDS.	1.00	SQFT		

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Item	Class-Item	Quantity	Unit	Unit Price	Total
	ITEMS 6, 7, 8, 9, 16, 17 AND 19 ARE REQUIRED IN VARIOUS COLORS AND SIZING RANGING FROM 1" X 50 YDS. TO 50" X 50 YDS. ITEMS 10-13, BID A PRICE PER FIFTY (50) SIGN FACES DELIVERY OF GOODS OR SERVICES AS REQUESTED BY AGENCY.			**TOTAL:**	_____

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SECTION M.16

SIGNS AND SIGN SUPPORTS

M.16.02 REFLECTIVE SHEETING.

M.16.02.1 General. The reflective sheeting covered by this Specifi cation shall consist of a retroreflective system having a smooth outer surface. When an adhesive backing is used, the sheeting shall have a precoated adhesive on the back protected by an easily removable liner.

a. Type IIIA and Type IIIB are high performance grade encapsu lated lens sheetings with designations "A" for glass bead and "B" for prismatic sheeting.

b. Type IV is a reflectorized, reboundable flexible sheeting designed for channeling devices with markings, and shall meet or exceed the retroreflection requirements, color conformance and all tests in accordance with ASTM D4956.

c. Type V is durable flour escent orange retroreflective sheeting for certain work zone signs.

d. Type VI is a prismatic retroreflective sheeting used for certain outside work zone signs.

AASHTO M268 Type I retroreflective sheeting, Type II engineering grade and Type IIA super engineering grade are not included in these Specifications.

M.16.02.2 Applications.

a. Type IIIA or Type IIIB Sheeting. Type IIIA, or Type IIIB sheeting shall be used on any sign for which Type V or Type VI sheeting is not specified.

b. Type IV Sheeting. Type IV sheeting shall be used on channeling devices with markings, including flourescent traffic cones, drum barricades and plastic pipe -type barricades.

c. Type V sheeting shall be used on:

1. All W20-1 and W21-4 signs.

2. All W3-1a, W3-2a, W4-1, W4-2, W10-1, E5-1 and E5-1a signs within work zones with orange background sheeting choice.

3. All G20 Series.

d. Type VI sheeting shall be used on all R1 -1, R1-2, R4-7, R5-1, R5-1a, W3-1a, W3-2a, W4-1, W4-2, W10-1 signs, Hazard Markers Type 1, 3 , and Typical End -of-Road Markers, E5 -1 and E5-1a series.

M.16.02.3 Material Requirements, Type IIIA, IIIB, and Type IV Sheeting.

a. Color Requirements. The colors specified shall conform to the applicable requirements of AASHTO M268 except modifi ed as follows:

1. Silver is an acceptable color designation for white.

The purchaser may accept colors by certification or may require the Contractor to provide copies of laboratory test reports to substantiate compliance with contract color requiremen ts.

When testing is required, the test instrument used shall be one of the following or an approved equal:

X GARDNER Model AC-2a Color Difference Meter or Model XL 30 Color Difference Meter.

X HUNTERLAB D25 Color Difference Meter

Test panels shall be mount ed in accordance with the manufact urer's recommen dations.

b. Specific Intensity Per Unit Area (SIA). The reflective sheeting shall have the minimum SIA requirements as shown in Tables 1 and 2 for the Type(s) of sheeting specified. SIA is expressed in "candelas per foot candle per square foot" (candelas per lux per square meter). Measurement of SIA shall be conducted in accordance with the applicable require ments. Test panels shall be mounted in accordance with manufacturer's recommendations.

Table 1
Minimum Specific Intensity Per Unit Area (SIA)
(candelas per footcandle per square foot)

Type III Sheeting

A -- Glass Bead Reflective Element Material

Observation Angle (^{O})	Entrance Angle (^{O})	White	Red	Orange	Yellow	Green	Blue
0.2	-4	250	45	100	170	45	20.0
0.2	+30	150	25	60	100	25	11.0
0.5	-4	95	15	30	62	15	7.5
0.5	+30	65	10	25	45	10	5.0

B -- Prismatic Reflective Element Material

Observation Angle (^{O})	Entrance Angle (^{O})	White	Red	Orange	Yellow	Green	Blue
0.2	-4	250	45.0	100	170	45.0	20.0
0.2	+30	95	13.3	26	64	11.4	7.6
0.5	-4	200	28.0	56	136	24.0	18.0
0.5	+30	65	10.0	25	45	10.0	5.0

Table 2
Minimum Specific Intensity per Unit Area (SIA)
(candelas per lux per square meter)

Type IV Sheeting

Observation Angle (^{O})	Entrance Angle (^{O})	White	Flourescent Orange
0.2	-4	550	180
0.2	+30	330	100

c. Specular Gloss. The reflective sheeting shall have an 85 degree specular gloss of not less than 50 for Type s IIIA, IIIB, and IV when tested in accordance with ASTM D523.

d. Color Processing. Color processing shall be in accor dance with the applicable requirements of AASHTO M268.

e. Shrinkage. Shrinkage shall be in accordance with the applica ble require ments of AASHTO M268 except the shrinkage of Type III reboundable sheeting shall not be more than 0.10 -inch in 24 hours in any dimension.

f. Flexibility. Type III and IV sheeting, with the liner removed and condi tioned for 24 hours at 72^{O}F (22^{O}C) and 50 percent relative humidity shall be sufficient ly flexible to show no cracking when slowly bent around a 1/8 -inch (3.2 mm) mandrel with adhesive contacting the mandrel. For ease of testing, spread talcum powder on adhesive to prevent sticking to mandrel . The test specimen shall be 2 :-inches by 11 inches.

Non-adhesive sheetings shall show no signs of cracking or crazing when flexed repeatedly over a 1/16 -inch mandrel to 180 at 72 ^{O}F.

Type III reboundable sheeting shall be conditioned and tested at 32 ^{O}F.

g. Adhesive. When an adhesive is used, the reflective sheeting shall have either a pressure sensitive adhesive backing (Class 1) or a heat activated adhesive backing (Class 2) which shall provide for application of the sheeting without the necessity of additional adhesive coats on either the reflective sheeting or application surface.

The Class 1 adhesive shall be a pressure sensitive adhesive of the aggressive tack type

requiring no heat, solvent, or other preparation for adhesion to smooth clean su rfaces. The Class 2 adhesive shall be an adhesive activated by applying heat in excess of 175 ^{O}F (73^{O}C) to the material as in the heat -vacuum process of sign fabrication.

The protective liner attached to the adhesive shall be removed by peeling without so aking in water or other solvents without breaking, tearing or removing any adhesive from the backing. The protective liner shall be easily removed following accelerated storage for 4 hours at 160 ^{O}F (71^{O}C) under a weight of 2.5 pounds per square inch (0.18 kg/cm^{2}).

The adhesive backing of the reflective sheeting shall produce a bond to support a 1 **:** pound (0.79 kg) weight for 5 minutes, without the bond peeling for a distance of more than 2 inches (5.08 cm) (1 inch for Type III reboundable sheeting) when ap plied to a smooth aluminum surface and tested as specified.

h. Impact Resistance. The impact resistance of Type III and IV reflective sheeting shall conform to the applica ble requirements of AASHTO M268 with the following exception: For Type III reboundable and Type IV sheeting, a 100 inch -pound setting shall be used on the test instrument. Type III reboundable sheeting shall also be further conditioned and tested at 32 ^{O}F.

i. Accelerated Weathering. When applied in accordance with recommended pro cedures, the reflective sheeting shall be weather resistant and, following cleaning in accordance with manufacturer's recommendations, shall show no appreciable discoloration, cracking, blistering or dimensional change. Following exposure, the panels shal l be washed with a 5 percent hydrochloric acid solution for 45 seconds, rinsed thoroughly with clean water, blotted with a soft clean cloth, brought to equilibrium at standard conditions and tested. It shall have not less than the percent of the minimum S IA specified in Table 3 when subjected to accelerated weathering in accordance with ASTM G23, Type E or EH Weatherometer with humidifi er off.

Table 3
Accelerated Weathering Testing Requirements

Type III & IV Sheeting

Type of Material	Hours Tested	Minimum Specific Intensity Per Unit Area
III	*2,200	80% of Table 1
IV	250	50% of Table 2

* For orange material having glass bead retroreflective elements and for Type III reboundable sheeting, the hours tested shall be 500.

M.16.02.4 Material Requirements - Type V Sheeting

a. Photometric - Coefficient of Retroreflection R_A. When the sheeting applied on aluminum test panels is measured in accordance with ASTM E810, it shall have minimum coefficient of retroreflection value s as shown in Table 4. The rotation angle shall be 90 ^{O}, the observation

angles shall be 0.2 ^{O}, and 0.5 ^{O}, the entrance angels (component B1) shall be -4^{O}, and +30 ^{O}, and the entrance angle component B2 shall be 0 ^{O}.

Table 4
Minimum Coefficient of Retroreflection R_A
(candelas per footcandle per square foot)
(90^{O} Rotation Angle)

Type V Sheeting

Observation Angle (^{O})	Entrance Angle (^{O})	Orange
0.2	-4	200
0.2	+30	90
0.5	-4	80
0.5	+30	50

b. Daytime Color. Color shall conform to the requirements of Table 5. Daytime color and maximum spectral radiance factor (peak reflectance) of sheeting mounted on aluminum test panels shall be determined instrumentally in accordance with ASTM E991. The values shall be determined on a Hunter Lab Labscan 6000 0/45 Spectrocolorimeter with option CMR 559 [or approved equal 0/45 (45/0) instrument with circumferential viewing (illumination)]. Computations shall be done in accordance with ASTM E308 for the 2 ^{O} observer.

Table 5
Color Specification Limits* (Daytime)

Type V Sheeting

									Reflectance Limit Y (%)	
Color	1		2		3		4			
	x	y	x	y	x	y	x	y	min.	max.
Orange (new)	.583	.416	.523	.397	.560	.360	.631	.369	30	B
Orange (weath-ered)	.583	.416	.523	.397	.560	.360	.631	.369	20	45
Maximum spectral radiance factor, new: 110%, min. - weathered: 60%										

c. Nighttime Color. Nighttime color of the sheeting applied to aluminum test panels shall be

determined instrume ntally in accordance with ASTM E811 and calculated in the u =, v= coordinate system in accordance with ASTM E308. Sheeting shall be measured at 0.33 ^{O} observation and -4^{O} entrance at 90 ^{O} rotation. Color shall conform to the requirements of Table 6.

Table 6
Color Specification Limits* (Nighttime)

Type V Sheeting

Color	1		2		3		4	
	u=	v=	u=	v=	u=	v=	u=	v=
Orange (new and weather -ed)	.400	.540	.475	.529	.448	.522	.372	.534

* The four pairs of chromaticity coordinates determine the acceptable color in terms of the CIE 1931 standard colorimetric system measured with standard illuminant D65.

d. Resistance to Accelerated Weathering. The retroreflective surface of the sheeting shall be weather resistant and show no appreciable cracki ng, blistering, crazing, or dimensional change after one year of unprotected outdoor exposure in south Florida, south -facing and inclined 45 ^{O} from the vertical, or after 1500 hours of exposure in a xenon arc weatherometer in accordance with ASTM G26, Type B, Method A. Following exposure, panels shall be washed in a 5 percent HCL solution for 45 seconds, rinsed thoroughly with clean water, blotted with a soft clean cloth and brought to equilibrium at standard conditions. After cleaning, the coefficient of retroreflection shall be not less than 100 when measured as indicated in **Para. d.2** of this Subsection, and the color is expected to conform to the requirements of Tables 5 and 6 for weathered sheeting. The sample shall:

1. Show no appreciable evidence o f cracking, scaling, pitting, blistering, edge lifting or curling or more than 1/32 -inch (0.08 cm) shrinkage or expansion.

2. Be measured only at angles of 0.2 ^{O} observation, -4^{O} entrance and 90 ^{O} rotation. Where more than one panel of a color is measure d, the coefficient of retroreflection shall be the average of all determinations.

e. Impact Resistance. The retroreflective sheeting applied according to the sheeting manufacturer =s recommendations to a test panel of alloy 6061 -T6, 0.040" (0.10 cm) by 3 " (7.6 cm) by 5" (12.7 cm) and conditioned for 24 hours, shall show no cracking outside the impact area when the face of the panel is subjected to an impact of 100 inch -pounds (11.3 Nm), using a weight with a 5/8-inch (15.8 mm) diameter rounded tip dropped from a height necessary to generate an impact of 100 inch-pounds, at test temperatures of both 32 ^{O}F (0^{O}C) and 72^{O}F (22^{O}C).

f. Resistance to Heat. The retroreflective sheeting, applied to a test panel as in **Para. e**, above, and conditioned for 24 hours , shall be measured in accordance with **Para. a** at 0.2^{O} observation and -4^{O} entrance angles at 90 ^{O} rotation and exposed to 170 $\forall$ 5^{O}F (77$\forall$ 3^{O}C) for 24 hours in an air circulating oven. After heat exposure the sheeting shall retain a minimum of 70

percent of the original coefficient of retroreflection.

g. Field Performance. Retroreflective sheeting processed and applied to sign blank materials in accordance with the sheeting manufacturer =s recommendations, is expected to perform effectively. The retroreflective sheeting will be considered unsatisfactory if it has deteriorated due to natural causes to the extent that 1) the sign is ineffective for its intended purpose when viewed from a moving vehicle under normal day and night driving conditions; or 2) the coefficient of retroreflection is less than 100 when measured at 0.2 ^{O} observation and -4^{O} entrance at 90 ^{O} rotation. All measurements shall be made after sign cleaning according to the sheeting manufacturer =s recommendations.

M.16.02.5 Material Requirements - Type VI Sheeting

a. Coefficient of Retroreflection, R_A. The coefficients of retroreflection shall not be less than the minimum values specified in Table 7. Testing shall be in accordance with ASTM D4956, latest edition.

Units: Coefficients of retroreflection R_A shall be specified in units of candelas per lux per square meter (candelas per footcandle per square foot).

The observation angles shall be as per ASTM D4956, latest edition.

For colored, transparent overlay films and for screen printed transparent color areas on white sheeting, the ratios of the R_A for the white to the R_A for the color, when measured at 0.2 ^{O} observation, -4^{O} entrance, and 0 ^{O} rotation, shall be 5:1 to 15:1 for red, not less than 5:1 for blue and not less than 5:1 for green when processed in accordance with the sheeting manufacturer =s recommendations.

Table 7
Minimum Coefficient of Retroreflection R_A
(candelas per lux per square meter)

Type VI Sheeting - ASTM D4956, Latest Edition

Observation Angle (^{O})	Entrance Angle (^{O})	Rotation Angle (^{O})	White	Yellow	Blue	Green
0.2	-4	0	430	350	20	45
0.2	+30	0	235	190	11	24
0.33	-4	0	300	250	15	33
0.33	+30	0	150	130	7	18
0.5	-4	0	250	200	10	25
0.5	+30	0	170	140	7	19
1.0	-4	0	28	22	2.4	5.0
1.0	+30	0	16	12	1.0	2.7

b. Color Requirements. Conformance to color requirements of Table 8 shall be determined by instrumental method in accordance with ASTM E1164 on sheeting applied to aluminum test

panels. The values shall be determined on a HunterLab Labscan 6000 0/45 Spectrocolorimeter with option CMR 559 [or approved eq ual 0/45 (45/0) instrument with circumferential viewing (illumination)]. Computations shall be done in accordance with ASTM E308 for the 2 ^{O} observer.

Table 8
Color Specification Limits* (Daytime)

Type VI Sheeting

									Reflectance Limit Y (%)	
Color	1		2		3		4			
	x	y	x	y	x	y	x	y	min.	max.
White	0.305	0.305	0.355	0.355	0.335	0.375	0.285	0.325	40	B
Yellow	0.487	0.423	0.545	0.454	0.465	0.534	0.427	0.483	24	45
Blue	0.078	0.171	0.150	0.220	0.210	0.160	0.137	0.038	1	10
Green	0.030	0.398	0.166	0.364	0.286	0.446	0.201	0.794	3	9

* The four pairs of chromaticity coordinates determine the acceptable color in terms of the CIE 1931 standard colorimetric system measured with standard illu minant D65.

c. Gloss. The retroreflective sheeting shall have an 85 ^{O} specular gloss of not less than 50 when tested in accordance with ASTM D523.

d. Color Processing. The retroreflective sheeting shall permit cutting and color processing with compati ble transparent and opaque process colors in accordance with the sheeting manufacturer=s recommendations at temperatures of 15 to 38 ^{O}C (59 to 100 ^{O}F) and relative humidities of 20 percent to 80 percent. The sheeting shall be heat resistant and permit force curing without staining of applied or unapplied sheeting at temperatures recommended by the sheeting manufacturer.

e. Flexibility. The retroreflective sheeting with the liner removed and conditioned at standard conditions shall be sufficiently flexible to show no cracking when slowly bent, in one second=s time, around a 3 mm (1/8 inch) mandrel, with the adhesive contacting the mandrel, at test conditions. Talcum powder shall be spread on the adhesive to prevent sticking to the mandrel.

f. Adhesive. The protective liner attached to the adhesive shall be removed by peeling without soaking in water or other solutions, without breaking, tearing, or removing any adhesive from the backing. The protective liner shall be easily removed following accelerate d storage for 4 hours at 70^{O}C (158^{O}F) under a weight of .175 Kg/cm ^{2} (2.5 pounds per square inch). The adhesive backing of the retroreflective sheeting shall produce a bond to support a .80 Kg (1.75 pound) weight for 5 minutes without the bond peeling for a distance of more than 5.0 cm (2 inches) when applied to a test panel. Apply 10 cm (4 inches) of a 2.5 cm x 15 cm (1" x 6") specimen to a test panel. Condition and then position the panel face down horizontally, suspend the weight from the free end of t he

sample and allow it to hang free at an angle of 90 ^{O} to the panel surface for 5 minutes.

g. Impact Resistance. The retroreflective sheeting applied according to the sheeting manufacturer =s recommendations to a test panel of alloy 6061 -T6, 0.10 cm (0.040 inches) by 7.5 cm (3 inches) by 12.5 cm (5 inches) and conditioned at standard conditions, shall show no cracking outside the impact area when the face of the panel is subjected to an impact of 5.65 Nm (50 inch - pounds) using a weight with a 1.6 cm (5/8 Inch) diameter rounded tip dropped from a height necessary to generate an impact of 5.65 Nm, at test temperatures of both 0 ^{O}C (32^{O}F) and 22^{O}C (72^{O}F).

h. Resistance to Accelerated Outdoor Weathering. The retroreflective surface of the sheeting shall be w eather resistant and show no appreciable cracking, blistering, crazing, or dimensional change after two years unprotected outdoor exposure, facing the equator and inclined 45^{O} from the vertical. Following weather exposure, panels shall be washed in a 5% H CL solution for 45 seconds, rinsed thoroughly with clean water, blotted with a soft clean cloth and brought to equilibrium at standard conditions. After cleaning, the coefficient of retroreflection shall not be less than the values in Table 9 when measur ed at 0^{O} rotation and the colors shall conform to the requirements of Table 8. The sample shall:

1. Show no appreciable evidence of cracking, scaling, pitting, blistering, edge lifting or curling or more than 0.8 mm (1/32 inch) shrinkage or expansion;

2. Be measured only at angles of 0.2 ^{O} observation, -4^{O} entrance, and 0 ^{O} rotation, and 1.0 ^{O} observation, -4^{O} entrance, and 0 ^{O} rotation. Where more than one panel of a color is measured, the coefficient of retroreflection shall be the average of all determ inations.

Table 9
Minimum Coefficient of Retroreflection R_A
after Accelerated Outdoor Weathering
(candelas per lux per square meter)

Type VI Sheeting

Observation Angle (^{O})	Entrance Rotation Angle (^{O})	Angle (^{O})	White	Yellow	Blue	Green
0.2	-4	0	250	200	11	25
1.0	-4	0	45	35	1.3	3

i. Resistance to Heat. The retroreflective sheeting, applied to a test panel and conditioned at standard conditions, shall be measured for retroreflectance at 0.2 ^{O} observation and -4^{O} entrance angles and 0 ^{O} rotation and exposed to 77 $\forall$ 3^{O}C (170$\forall$ 3^{O}F) for 24 hours in an air circulating oven. After heat exposure the sheeting shall retain a minimum of 70 percent of the original coefficient of retroreflection when measured at room tempera ture.

j. Resistance to Corrosion. The retroreflective sheeting applied to a test panel and conditioned at standard conditions shall show no loss of adhesion, appreciable discoloration or

corrosion and after cleaning shall retain a minimum of 80 percent of the original coefficient of retroreflection when measured at 0.2 ^{O} observation, -4^{O} entrance and 0 ^{O} rotation angles after 1000 hours exposure to a 5 percent concentration of salt spray at 35 ^{O}C (95^{O}F) when tested in accordance with ASTM B117.

k. General Characteristics and Packaging. The retroreflective sheeting as supplied shall be of good appearance, free from ragged edges, cracks and extraneous materials, and shall be furnished in either rolls or sheets. When furnished in continuous rolls, the avera ge number of splices shall not be more than 3 per 50 meters (54.7 yards) of material with a maximum of 4 pieces in any 50 meter (45.7 yard) length. Splices shall be butted or overlapped and shall be suitable for continuous application as furnished. When furnished as cut sheets or sign faces, the sheeting shall be packaged flat in accordance with commercially accepted standards. The sheeting shall be packed snugly in corrugated fiberboard cartons, in accordance with commercially accepted standards. Each carton shall clearly stipulate the brand, quantity, size, lot or run number and color. Stored under normal conditions the retroreflective sheeting as furnished shall be suitable for use for a minimum period of one year.

l. Performance Requirements and Obligations.

1. Certification. The sheeting manufacturer shall, upon request, supply with each lot or shipment, a certification which states that the material supplied will meet all of the requirements listed herein.

2. Field Performance Requirements. After ten years in service the coefficient of retroreflection shall not be less than the values listed in Table 10.

Table 10
Minimum Coefficient of Retroreflection R_A
after Ten Years
(candelas per lux per square meter)

Type VI Sheeting

Observation Angle (^{O})	Entrance Angle (^{O})	White	Yellow	Blue	Green
0.2	-4	250	200	10	23
1.0	-4	45	35	2	5

All measurements shall be made after sign cleaning according to the sheeting manufac - turer=s recommendations.

Natural cause s include effects of exposure to weather. Natural causes exclude (without limitation) damage from exposure to chemicals, abrasion and other mechanical damage from fasteners used to mount the sign, collisions or mishandling.

For screen printed transparen t colored areas on white sheeting, the coefficients of retroreflection shall maintain the ratios required for new sheeting.

3. Process Inks. The manufacturer of the sheeting shall furnish at no additional cost the process inks, clears and thinners reco mmended for the sheeting to meet the performance requirements of this Specification, and shall further be responsible for technical assistance in the use of these inks in accordance with this Specification.

4. Slip Sheet. Slip sheet paper, if recommende d by the sheeting manufacturer for sheeting surface protection or for use in packaging, storage or shipping finished signs, shall be furnished in rolls by the manufacturer at no additional charge, in at least equal dimension (square meters) and in the same sizes as the sheeting supplied.

5. Washers. Washers, if recommended by the sheeting manufacturer to protect the sign surface from damage by bolts or other fasteners, shall be furnished by the manufacturer at no additional charge.

m. Fabrication Date. The sign fabricator shall date all signs at the time of fabrication with the fabrication date so that the start of the warranty period can be determined.

M.16.02.6 Testing Procedures.

a. Testing Conditions. Unless otherwise specified herein, all a pplied and unapplied test samples and specimens shall be conditioned at the standard conditions of 23 ∀ 3^{O}C (73∀ 3^{O}F) and 50∀5 percent relative humidity for 24 hours prior to testing.

b. Testing Panels. Unless otherwise specified herein, when tests are to be performed using test panels, the specimens of retroreflective material shall be applied to smoot h aluminum cut from ASTM B209 Alloy 5052 -H36, 5052-H38, 5154-H38 or 6061-T6 sheets in 0.05 cm (0.020 inch), 0.10 cm (0.040 inch) or 0.16 cm (0.063 inch) thickness. The aluminum shall be degreased and lightly acid etched before the specimens are applied. The specimens shall be applied to the panels in accordance with the recommendations of the retroreflective sheeting manufacturer.

c. Specific Intensity Per Unit Area (SIA). Measurements shall be conducted in accordance with Instrumental Photometric Meas urements of Retroreflective Materials and Retroreflective Devices, Federal Test Method Standard 370. Test will be conducted at 50 feet with 1 -inch source and 1-inch receiver on 12 -inch square test specimen. Observation and entrance angles shall be in the same plane.

Rotate specimen to orientation angles recommended by the manufac turer. The presentation angle is zero.

The SIA of the sheeting when totally wet, shall not be less than 90 percent of the dry values in Tables 1, 2, 4 and 7. Wet performance measurements shall be made on new sheeting in accordance with the standard rainfall test specified in Section 7.10.1 of AASHTO M268.

d. Adhesion Test. Adhesion test shall be in accordance with the applicable requirements of AASHTO M268.

e. Colorfastness. The colorfastness test shall be in accor dance with the applicable requirements of AASHTO M268 except that the specimens shall be prepared and subjected to

accelerated weathering as specified above.

f. Fungus Resistance. For use in areas where fu ngus growth may be a problem and if specified by the Engineer, fungus resis tance shall be determined as specified herein.

After inoculation with the test organism, Aspergillus niger, and incubation for 14 days, the reflective material shall show no appre ciable formation of fungus growth. Any formation of fungus growth shall be non -injurious to the reflective material and shall be removable by wiping with a soft cloth. After completion of the incubation and after being wiped clean, the reflective materia l shall retain the full SIA values as specified in Tables 1, 2, 4 and 7.

1. Test Organism. The test organism used in this test shall be **Aspergillus Niger, ATCC No. 6275**. (This organism may be obtained upon request from the American Type Culture Collec tion (ATCC), 12301 Parklawn Drive, Rockville, Maryland 20852, or Mycology Laboratory, PRL, U.S. Army Natick Laboratories, Natick, Massachu setts 01760.) Cultures of this organism shall be carefully maintained on a potato -dextrose agar medium and promptly renewed if there is evidence of contamina tion. The stock cultures may be kept for not more than 4 months in a refrigerator at a temperature from 37.4 ^{O}F to 50 ^{O}F (3^{O}C to 10^{O}C). Subcultures incubated at 82.4 ^{O}F to 86 ^{O}F (28^{O}C to 30^{O}C) for 10 to 14 days shall be used in preparing the inocu lum.

2. Culture Medium. The culture medium shall have the following composition:

$NaNO_3$	- 3.0 grams
K_2HPO_4	- 1.0 grams
$MgSO_4 7H_2O$	- 0.5 grams
KCI	- 0.25 grams
Agar	-15.0 grams
Distilled water to make 1,000 ml.	

The pH shall be 5.5 to 6.5: if otherwise, adjust to that range with HCL or NaOH. After mixing, the ingredients shall be steril ized by autoclaving for 15 minutes at 15 psi (1.05 kg -cm^2) at 248^{o}F (120^{o}C).

Under sterile conditions, the medium shall be p oured into 6, 150 mm by 20 mm petri dishes, about 65 ml per dish, and allowed to harden.

3. Inoculum. Add about 10 ml of sterile, distilled water containing about 0.005 percent of nontoxic wetting agent to a subculture (10 to 14 days old) of the test or ganism in a ripe, fruiting condition. The spores shall be forced into suspen sion with a sterile camel's hair brush (or other suitable means) and diluted to 100 ml with sterile, distilled water.

4. Preparation of Specimens. Cut three, 3" x 3" (7.62 cm by 7.62 cm) specimens from the sample and apply to test panels with the reflective surface up. Complete ly immerse the test specimens in a leaching tank of continuously flowing water for 24 hours and then remove and dry. The leaching tank shall be large enough to hold an amount of water weighing not less than 50 times the weight of the specimens. The water entering the tank shall not fall directly on the specimens and shall flow at a rate of 5 to 10 liters per hour. The pH of the water shall be in the r ange of 6.0 to 8.0.

5. Inoculation. Under aseptic conditions, dip each specimen in 70 percent ethanol for a few seconds, rinse in distilled water, and place firmly on the surface of the solidified agar medium

contained in the petri dishes. Place specim ens with the reflective surface facing up, one specimen to each dish. With a sterile pipette, distribute 1.0 to 1.5 ml of inoculum over the surface of each specimen and the surrounding medium.

6. Incubation Period. The period of incubation shall be 14 days at a temperature of 84.2 ^{O}F to 89.6 ^{O}F (29 ^{O}C to 32 ^{O}C) and 85 to 90 percent relative humidity.

7. Control. Test three control specimens of untreated, porous grade filter paper with the specimens of the reflective material to check the viability of th e inoculum. At the end of the incubation period, the controls should be covered with fungus growth.

8. Test Results. Upon completion of the incubation period, examine the specimens visually for fungus growth. Wipe the specimens with a soft cloth wet w ith a 70 percent ethanol solution. Condition the specimens at standard conditions for 48 hours. Test the specimens in accor dance with **Para. c** of this Subsection, and when finished, attempt to remove specimen from the test panel.

M.16.02.7 Intended Use. The reflective sheeting specified herein is intended for use on surfaces of highway signs to assure their optimum visibility by day and at night when exposed to a light source and whether dry or totally wet by rain.

Purchasers should select colors and preferred options permitted herein and specify the type of adhesive backing: Class 1, precoated pressure sensitive adhesive; or Class 2, heat activated adhesive as required.